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Traffic Manual	Kim Nystrom	PAGE 1 OF 1
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Attached is revised Chapter 7, Traffic Safety Systems, for insertion into your Traffic Manual. Please discard existing Chapter 7, Traffic Safety Systems, in its entirety.

This manual change should be implemented for all new construction and during routine maintenance operations.

The changes are:

- Section 7-04.3 This section is renamed Study Warrants, warrants are now refered to as study warrants, the median width is increased to 23 meters and reference to a developing accident history is removed.

- Section 7-04.4 The guidelines for the installation of median barriers is rewritten.

- Section 7-04.6 The guidelines for Planted Medians is rewritten and guidelines for Adding Lanes in the Median is added.

- Figure 7-7 Freeway Median Barrier Study Warrants is revised to reflect current policy and the increase of the median barrier width.

STATE OF CALIFORNIA
BUSINESS, TRANSPORTATION AND HOUSING
DEPARTMENT OF TRANSPORTATION

TRAFFIC MANUAL

CHAPTER 7
TRAFFIC SAFETY SYSTEMS

May, 1998

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CHAPTER 7
TRAFFIC SAFETY SYSTEMS

General Information 7-01

7-01.1 Introduction

Traffic safety systems are highway features designed primarily to reduce the severity of run-off-road accidents, prevent out-of-control vehicles from crossing the median and decelerate errant vehicles. These features include guardrail, crash cushions, median barrier, breakaway supports for signs and light standards, and truck escape ramps.

7-01.2 Standards

The Standard Plans contain design details for the construction of traffic safety systems. These designs are based on full-scale tests and typical conditions generally associated with new highway construction. Standard Plans cannot always be directly applied to all situations on existing roadways, and some design modifications may be needed. Modified or unique traffic safety system designs require review and approval of Headquarters' Traffic Operations Program.

Standards for traffic safety systems have evolved over time and continue to change in response to changing technology, research findings, and changes in the design and speed of vehicles. Consequently, many existing traffic safety systems do not comply with the latest design standards. It is not always economically feasible or cost-effective to upgrade these existing installations each time revisions are made to the standards. Existing installations should be reviewed periodically in accordance with the guidelines of the Traffic Safety Improvement Program so that cost-effective improvements may be made as funds become available. When other major work is done in the area, such as rehabilitation or reconstruction projects, traffic safety systems should be brought up to current standards, consistent with program guidelines.

Clear Zone Concept 7-02

7-02.1 Introduction

An area clear of fixed objects adjacent to the roadway is desirable to provide a recovery zone for vehicles that have left the traveled way. Studies have indicated that on high-speed highways, a clear width of 9 m from the edge of the traveled way permits about 80 percent of the vehicles leaving the roadway out of control to recover. Therefore, 9 m should be considered the minimum clear recovery area for freeways and high-speed expressways. High-speed is defined as operating speeds greater than 70 km/h.

On most conventional highways, because of lower speeds and volumes, a 9 m clear zone distance may be difficult to justify for engineering, environmental or economic reasons. For these reasons, a minimum clear recovery area of 6 m on conventional highways is advised. The designer must keep in mind that site-specific conditions such as volume, speed, alignment, side slope, weather, adjacent development, and environmental conditions should be evaluated when determining the clear recovery zone.

Obstacles located in the clear recovery zone should be removed, relocated, made breakaway,

or shielded by guardrail or crash cushions where justified in accordance with the following guidelines.

Additional information regarding this subject is available in the ***Roadside Design Guide***, American Association of State Highway and Transportation Officials (AASHTO), 1996 and the ***Highway Design Manual***.

7-02.2 Remove the Obstacle

There are several ways that a fixed object can be effectively eliminated from the clear recovery zone. By order of preference, they are:

1. Remove it if possible.

2. Move it to a location where it is unlikely to be hit, such as up a slope or behind a guardrail or wall that is required for other reasons.

3. Relocate it far enough from the traveled way to minimize its chances of being struck. Non traversable ditches, drainage structures, columns, utility poles, and overhead sign structures may be handled by this method.

4. Relocate an obstacle in the median or gore to a location beyond the right shoulder, thereby reducing the risk of exposure to at least one direction of travel.

7-02.3 Make the Obstacle Breakaway

If fixed objects such as light standards and ground-mounted sign supports cannot be moved out of the clear recovery zone, they should be considered for breakaway treatment.

The standard breakaway support for light standards is a three-point triangular slip-base. All light standards located where they can be struck by a vehicle should have a slip-base, except where pedestrians might be struck by the falling standard or it could conflict with traffic.

The laminated wood box beam is the standard breakaway support system for large ground-mounted signs. Laminated wood box beam posts have replaced large timber poles for new installations.

Intermediate size ground-mounted signs may be mounted on dimensioned wood posts. Any post 100 mm x 150 mm or larger should be drilled to make it breakaway. Details for the size and location of the holes are contained in the Standard Plans.

Small ground-mounted signs may be supported on dimensioned wood posts or approved commercially available yielding steel supports.

Mailboxes should be mounted on wood posts no larger than 100 mm x 100 mm or steel pipe no larger than 50 mm in diameter. Multiple mailboxes should never be mounted on a longitudinal rail. There is a commercially available yielding mailbox support system that will accommodate up to four mailboxes. The cluster mailboxes installed by the U.S. Postal Service do not perform acceptably on impact and should not be installed in the clear zone beside high-speed highways. For approved mailbox support design and placement, see ***A Guide for Erecting Mailboxes on Highways***, AASHTO, 1994.

Call boxes and chain control signs should be mounted on slip-bases where appropriate. Other features in the vicinity should not impede the function of the breakaway device or adversely influence the vehicle response.

7-02.4 Shield the Obstacle

If it is not practical to eliminate, relocate, or make a fixed object break away, then the object should be shielded. All the systems available to shield fixed objects are also fixed objects. They do not prevent an accident but are intended to reduce the severity of the accident. Longitudinal barriers such as guardrail, median barrier, and bridge railing are designed to redirect a vehicle away from its errant path. These barriers have been tested for structural integrity and occupant risk.

Crash cushions are designed to safely decelerate a passenger car to a stop in head-on impacts. When a vehicle strikes the cushions, it expends its kinetic energy by forcing water out through orifices, crushing material, tearing metal, displacing sand, or dragging a metal cable or strap through a restricted path. Crash cushions are generally used to shield relatively narrow objects such as piers, columns, overhead sign supports, and median barrier installations. A list of approved crash cushions may be obtained from your District Traffic Safety Systems Coordinator or Headquarters' Office of Traffic Safety Program and Research.

Guardrail 7-03

7-03.1 Introduction

Guardrail is the most common traffic safety system found on highways in California. Guardrail is installed to reduce the severity of run-off-road accidents. This is accomplished by redirecting a vehicle away from embankment slopes or fixed objects and dissipating the energy of the errant vehicle. However, guardrail will reduce accident severity only for those conditions where striking the guardrail is less severe than going down an embankment or striking a fixed object. Guardrail should only be installed where it is clear that accident severity will be reduced.

Consideration should first be given to eliminating or minimizing conditions requiring guardrail. This can be done by flattening embankment slopes and the careful location and design of roadside appurtenances.

Special consideration should be given to eliminating or relocating solitary fixed objects that cannot be made breakaway or yielding. The cost of eliminating the object may be offset by savings from reduced collision frequency and maintenance. Guardrail required to provide protection at such objects increases exposure and may result in an increase in the number of accidents.

Guardrail should not be used as a barricade or to prevent indiscriminate use of otherwise clear portions of the roadside.

7-03.2 Guardrail Types

The approved types of guardrail are:

(1) Metal Beam, and

(2) Concrete.

Metal beam guardrail is the standard for embankment and fixed object protection.

Concrete guardrail may be used in place of metal beam guardrail to reduce recurrent delays to motorists caused by lane closures, provide a damage-resistant barrier, and reduce exposure of Maintenance Division personnel to traffic if all the following criteria are met:

1. The proposed location is in a metropolitan area (population is greater than 200,000).

2. The distance from the edge of the traveled way to the face of the guardrail is less than 4.3 m.

3. There is less than a 6 hour working window for maintenance work during a 5 day work week, as determined by the District Traffic Operations Branch, based on traffic volume projections of growth for the next 5 years.

4. The proposed location has been struck three or more times in the last year.

Justification for the placement of concrete barrier on new construction should be based on criteria 1 through 3 only.

Under special circumstances, exceptions to these criteria may be granted for metropolitan or rural areas on a case-by-case basis. Exceptions must be approved in writing by a Headquarters Traffic Reviewer.

Three types of approved concrete barrier may be used. Types 50, 60 and 27B are best suited for permanent installations; for temporary or short-term installations (3 years or less), Type K barrier may be used.

The approach end of the concrete barrier must be shielded from traffic. The following are recommended methods of shielding:

1. Bury the end of the concrete barrier in a cut slope.

2. Extend the end of the concrete barrier at a 1:20 or flatter flare beyond the clear recovery zone.

3. Install an approved crash cushion at the approach end of the concrete barrier.

Concrete barrier must be anchored to prevent movement. Type 27B is anchored by its continuous footing; Types 50 and 60 require a 3 m long footing at each end; Type K is anchored by four 24 mm diameter dowels, 600 mm long, per section.

Types 50 and 60 and Type K barriers should have 50 mm thick asphalt concrete from the edge of the pavement to the back edge of the concrete barrier to prevent erosion. Pavement should extend to the base of the Type 27B barrier.

7-03.3 Embankment Guardrail

The primary contributors to the severity of over-embankment accidents are the height and slope of the embankment or side hill. Guardrail is a fixed object and should be installed only at locations where going off the embankment would be more severe than hitting the guardrail, and there has been a history of over-embankment accidents.

The procedure to be followed when embankment guardrail is being considered at a given location is as follows:

1. ***Accidents.*** Guardrail should be installed only at locations with a high run-off-road accident history or where there is a significant potential for such accidents. Evaluate the accident history, if available, or the potential frequency of accidents at the location based on the following general considerations:

a. ***Alignment.*** Isolated curves on otherwise high-standard roads increase the probability of running off the road. Also on roads with curves, run-off-road accidents are more likely to occur on the first curve in a series of curves, successive curves with a speed change greater than 15 km/h, curves that are sharper than those generally used, compound curves, or curves with larger central angles. The outside of curves of less than about a 300 m radius and especially those on sustained downhill grades in excess of 2 percent should be given special consideration.

b. ***Volume of Traffic.*** The higher the volume of traffic, the greater the probability that run-off-road accidents will occur.

c. ***Roadside Recovery Area.*** The narrower the recovery area, the greater the probability that a run-off-road vehicle will go down an embankment.

d. ***Climatic Conditions.*** Frequent dense fog or snow and ice conditions increase the probability of a vehicle running off the road and going down an embankment. In addition, locations subject to high velocity cross winds have an increased probability of vehicles running off the road.

2. ***Severity.*** Determine the relative severity of going off the embankment vs. hitting the guardrail using Figure 7-1, Equal Severity Curve. The Equal Severity Curve was developed from a field review of over-embankment accidents on freeways and full-scale vehicle tests on flatter embankments. The line shown represents combinations of embankment height and slope that result in accident severities generally equal to average guardrail accident severity. Overall, accident severity will be less if guardrail is used on embankments that plot substantially above the line. Where conditions close to the line are considered accident severities at specific embankment locations may be either greater or less than those of striking guardrail. Thus the curve should be regarded as a band rather than a line.

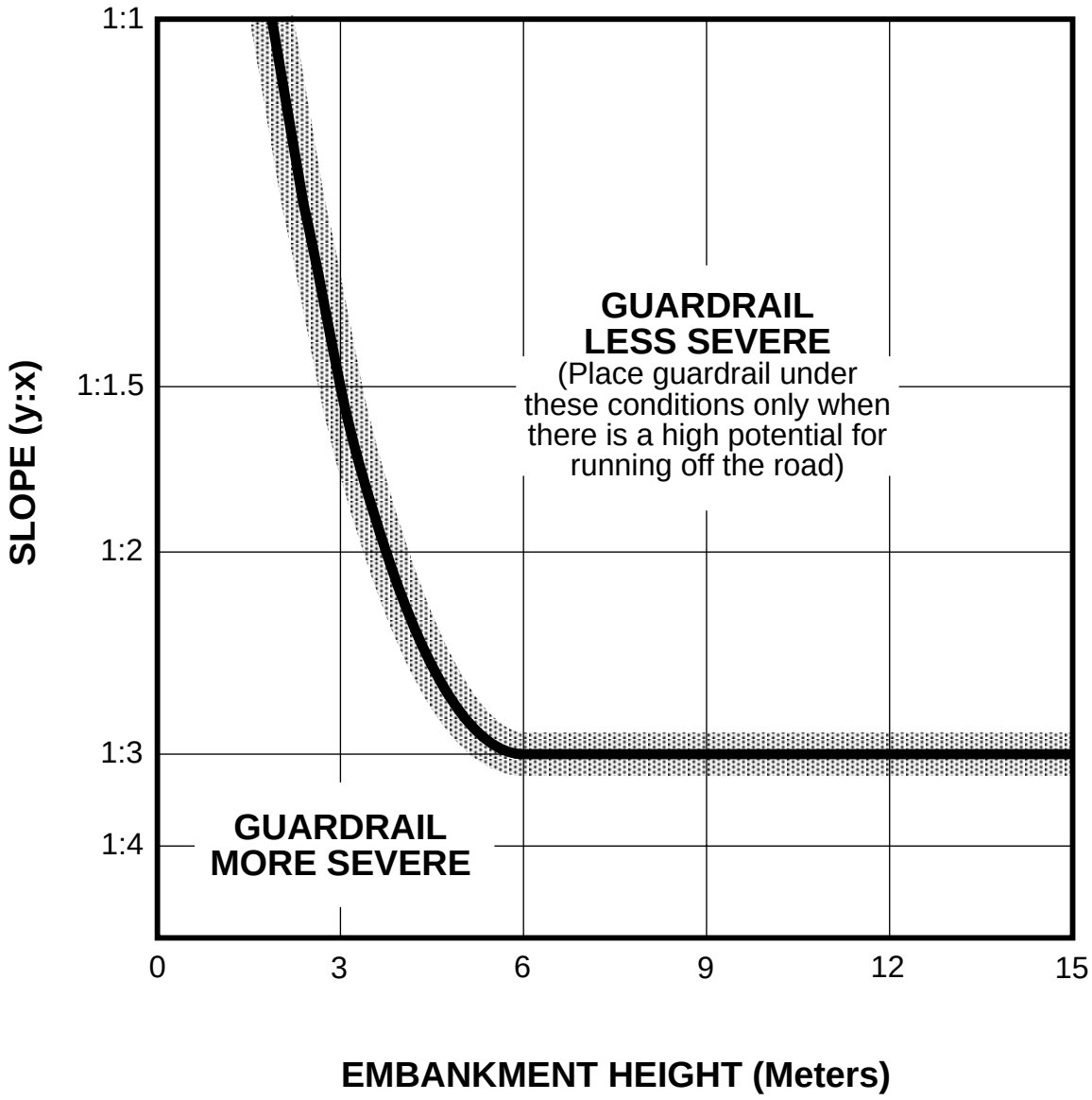
3. Based on the accident history or accident potential and Equal Severity Curve, decide whether guardrail should be installed.

7-03.4 Guardrail at Fixed Objects

Guardrail should be considered at all fixed objects that are accessible to traffic and within 9 m of the traveled way on freeways and high-speed expressways. Guardrail may also be considered at fixed objects located more than 9 m from the traveled way on freeways and expressways or 6 m on other highways when such objects occupy an otherwise clear recovery area. This applies whether the fixed object is located to the right or left of traffic and includes medians or roadway separations. In some cases, the object of concern may be located outside the right-of-way. Objects with slip-bases or breakaway features and those that yield because of their small size are not considered fixed objects for this application.

The same general principles apply to shielding fixed objects on non-freeways; however, the wide variety of roadside conditions on conventional highways preclude the establishment of firm rules. Lower speed roads require less clear distance.

Figure 7-1
EQUAL SEVERITY CURVE
(See Text for Instructions)



This is discussed in considerable detail in Chapter 3 of the ***Roadside Design Guide.*** In addition, the installation of guardrail along the roadsides of conventional highways is sometimes incompatible with adjacent property use.

In general, guardrail is not installed to shield fixed objects located behind curbs in urban areas because of lower speeds and the presence of parked cars, poles, hydrants, etc. See the Highway Design Manual for horizontal clearances. Individual trees, signal poles, lighting standards and utility poles are usually not shielded because the guardrail used to provide such protection increases overall fixed object exposure.

1. ***Structure Approaches.*** This applies to the ends of bridge railings or parapets exposed to approaching traffic. See Figure 7-2, Guardrail at Roadside Features.

   a. ***Two-Way Roadbeds.*** When the roadbed width across the structure is less than 18 m, guardrail should be placed on both sides at each end of the structure. When the roadbed width is 18 m or more, guardrail should be placed only to the right of approaching traffic.

   b. ***Divided Highways.*** Guardrail should be placed to the right and left of approaching traffic. Railings, guardrail, and bridge railing should not be placed transversely across the median or separation openings between adjacent or parallel structures. Protection should be provided by bridge approach guardrail with adequate length and an appropriate flare.

2. ***Other Fixed Objects.***

   a. Guardrail should be placed at the following fixed objects that are not shielded by other traffic safety systems:

      (1) Steel overhead sign posts.

      (2) Structure piers, columns, and abutments.

      (3) Exposed ends of retaining walls.

   b. Guardrail should be considered for rows of trees with trunks 150 mm or greater in diameter and spaced less than 15 m apart.

   c. Guardrail is not required at dimensioned lumber sign posts, metal light poles that have a breakaway or slip base, or at breakaway sign posts.

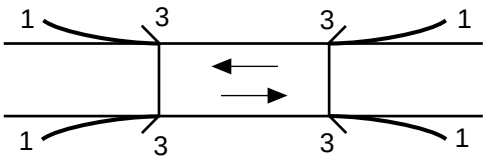
   d. Guardrail may be considered at all fixed objects listed in (a) above that are located more than 9 m from the traveled way on freeways or 6 m on other highways when such objects occupy an otherwise clear recovery area.

   e. In medians or roadway separations that are less than 30 m wide and are traversable by traffic, structure piers or columns should be shielded with guardrail or crash cushions.

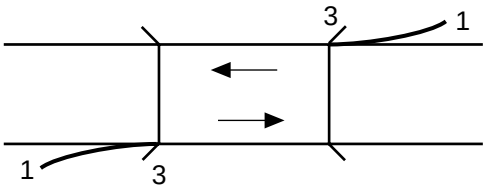
   f. Guardrail placed to shield a roadside feature on a two-way roadbed less than 18 m wide should shield both directions of travel. Where the roadbed is more than 18 m wide, guardrail is needed only for adjacent traffic. See Figure 7-2, Guardrail At Roadside Features.

Figure 7-2
GUARDRAIL AT ROADSIDE FEATURES

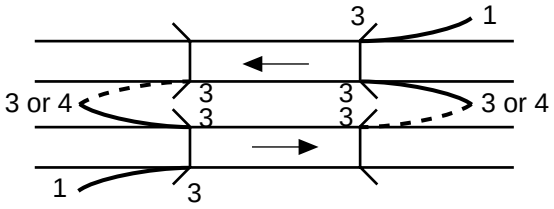
STRUCTURE APPROACHES



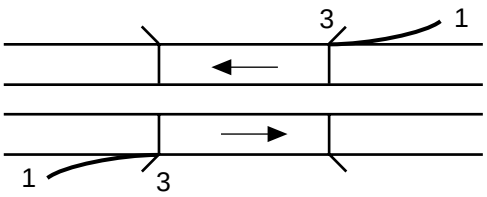
TWO-WAY HIGHWAY BRIDGE ROADBED < 18 m.



TWO-WAY HIGHWAY BRIDGE ROADBED ≥ 18 m.

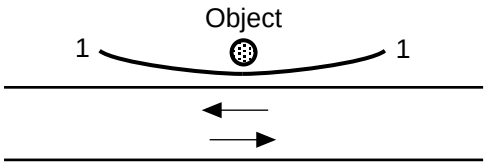


MULTI-LANE WITH SEPARATE STRUCTURES
(See Standard Plans for determination of flare type and crash cushion placement.)

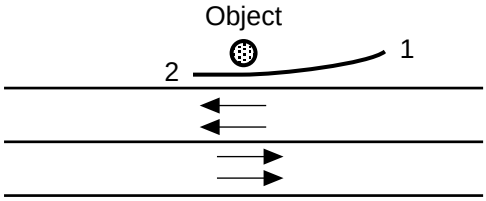


MULTI-LANE WITH DECKED MEDIAN ON BRIDGE

ROADSIDE OBJECTS

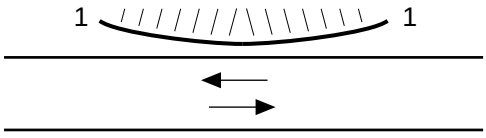


TWO-WAY ROADBED < 18 m.

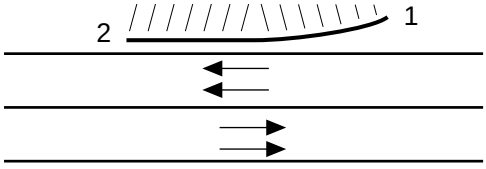


TWO-WAY ROADBED ≥ 18 m.
ONE-WAY ROADBED EITHER SIDE, ANY WIDTH

EMBANKMENTS



TWO-WAY ROADBED < 18 m.



TWO-WAY ROADBED ≥ 18 m.
ONE-WAY ROADBED EITHER SIDE, ANY WIDTH

LEGEND:

1. Cable Anchor Breakaway - Type M, Typical.
2. Cable Anchor Breakaway - Type B.
3. Positive Anchorage to Structure.
4. Other Anchorage (with protection in "Clear Zone").

7-03.5 Design Considerations

1. ***Length.*** Guardrail should only be as long as necessary to provide protection. Guardrail approaching fixed objects should typically have a minimum length of 15 m preceding the object exclusive of an approved end treatment. Longer lengths of guardrail may be needed on embankments where, in effect, the approach guardrail becomes an embankment guardrail. Where fixed objects are added behind existing guardrail, care should be taken that all fixed objects are within the area shielded by the guardrail. Fixed objects should not be allowed behind breakaway anchors.

2. ***Anchorage***. Guardrail functions as a tension member, much like a bowstring, redirecting the errant vehicle away from the obstacle. Thus it is necessary that both ends of all guardrail installations be anchored. When end anchors are damaged in a collision, they should be reconstructed to current standards. Revisions may include extension of the guardrail to place the approach end in a safer location, revision of the approach flare, upgrade of guardrail, removal of dike, or installation of a breakaway anchor or experimental end treatment.

    a. ***Buried End Anchor.*** This is the preferred treatment for the approach end of the guardrail. It may be necessary to extend a guardrail installation a reasonable amount to reach a cut section where a buried end anchor can be used. To prevent vaulting, care should be taken that the top of the rail remains at 685 mm above the ground until the base of the cut slope is reached.

    b. ***Cable Anchor Assembly Breakaway - Type M.*** This anchor, or other approved crashworthy attenuating terminals, should be used on the end of guardrail exposed to approaching traffic, which includes both ends of guardrail installations on two-way roadbeds less than 18 m wide. The Cable Anchor Assembly Breakaway-Type M is designed to lessen the severity of an end-on collision. A colliding vehicle is either redirected along the rail or allowed to pass through the end without sustaining forces greater than it would experience in striking the main portion of the guardrail. As much recovery area as practical should be provided behind a breakaway anchor. Fixed objects behind the guardrail, such as poles or trees, should not be located longitudinally within 15 m of a Cable Anchor Assembly Breakaway-Type M. The 11.3 m parabolic flare with 1.2 m setback at the approach end of guardrail installations incorporating the breakaway cable anchor is essential to reduce the risk of a vehicle being impaled in an end-on impact. It may be necessary to extend a guardrail installation to acquire room for the 1.2 m setback.

    c. ***Cable Anchor Assembly Breakaway - Type B.*** This anchor is intended for use on the trailing end of guardrail installations on one-way roadways or two-way roadways 18 m or wider where the Type M assembly has been used on the approach end. The Type B anchor is not intended for breakaway use on the approach end.

d. ***Non-breakaway Anchors.*** The Cable Anchor Assembly (non-breakaway) shown in the Standard Plans should be used only where the end of a guardrail installation cannot be impacted by an approaching vehicle. An exception is its use at the ends of double barrier and guardrail. No breakaway anchor is currently available for these installations. Crash cushions should be placed in front of non-breakaway anchors located in the clear zone to provide a crashworthy installation. Also, a non-breakaway anchor should be used to add intermediate anchorage where there is an abrupt change in the alignment of the guardrail, such as when the guardrail is continued down an intersecting road. A breakaway anchor with drilled posts set in a foundation should not be used for intermediate anchorage.

   Guardrail approaching structures is anchored to or at the structure. In general, guardrail may be anchored to abutments and structure railings that are designated barrier railings. Guardrail should not be fastened to structure columns. Holes drilled for anchor bolts can compromise the integrity of earthquake reinforcement. Where existing masonry and lightly reinforced concrete walls are involved, an independent anchor should be used. Connections may be made to new installations of concrete barrier.

3. ***End Conditions.*** In general, the approach end of all guardrail installations should be flared away from approaching traffic, as shown in the Standard Plans. On two-way roadways less than 18 m wide, both ends of all guardrail installations should be flared away from the roadway. Where it is not possible to flare the approach end of guardrail away from approaching traffic due to terrain conditions, there are specialty end treatments available that do not require a flare. For information on which end treatments are approved for use on California highways and for assistance in choosing an appropriate system, contact your Traffic Safety Systems Coordinator or Headquarters' Traffic Operations Program.

4. ***Transitions***. Metal beam guardrail is a semi-rigid barrier and must be gradually stiffened as it approaches connections to or at rigid objects such as bridge railings, retaining walls, abutment walls, or other structure supports. Gradual stiffening permits an impacting vehicle to be smoothly redirected away from the rigid object. Gradual stiffening is accomplished by reducing the post spacing for the six posts closest to the rigid object. In addition, the three posts closest to the object are increased in size.

   Transitions are required for guardrail approaching structures. Transitions are also necessary where the face of the guardrail is less than 1.2 m in front of the rigid object. Such locations may be a structure column, wall, or sign support. Where there is a row of structure columns with less than 8 m between columns, the reduced post spacing with larger posts should be continued between the columns. Where the column spacing exceeds 8 m, a new transition may be started.

5. ***Length and Position.*** Nearly all vehicles that run off the road do so at angles less than 25 degrees. The majority of run-off-road accidents occur with departure angles between 10 and 15 degrees, or typically 12.5 degrees.

Generally, a 15 m length of guardrail preceding the area of concern provides adequate coverage for these conditions. Greater lengths of guardrail may be necessary where the area of concern extends along the roadway or away from the roadway in an otherwise clear area. Figure 7-3, Position Of Guardrail At Fixed Objects, illustrates how additional guardrail may be needed to shield an area of concern extending back from the edge of the roadbed on a one-way road. Figure 7-3 also illustrates how the length of a guardrail installation may be reduced where there is a clear recovery area between the edge of the shoulder and the fixed object, and the cross slope is 1:10 or flatter. The guardrail may be placed as far as possible from the edge of the pavement, but no closer than 1.2 m from the face of the rail to the object. This clearance between the guardrail and the fixed object is necessary, since guardrail deflects up to 0.9 m during impact. The extra 0.3 m is to allow for those instances where a guardrail post would intrude into the 0.9 m clearance. Where an object is so close to the road that guardrail installed with 1.2 m of clearance would intrude into the roadbed, it is permissible to fasten the guardrail to the face of the object, other than a structure column, as shown in the Standard Plans. Where guardrail is fastened to a fixed object or passes within 1.2 m of a fixed object the guardrail should be stiffened with larger posts at closer spacing, as shown in the Standard Plans.

Gaps of less than 60 m between guardrail installations and gaps between the end of cuts and the beginning of guardrail should be avoided. Where such a gap is essential for maintenance purposes, removable rail panels can be installed. A gap for maintenance use may be left at the departing end of embankment guardrail on one-way roadbeds, or two-way roadbeds with a width greater than 18 m. Where there is recovery area between the edge of the travelled way and the edge of a high embankment, the guardrail should be installed near the edge of the embankment, preserving the recovery opportunity.

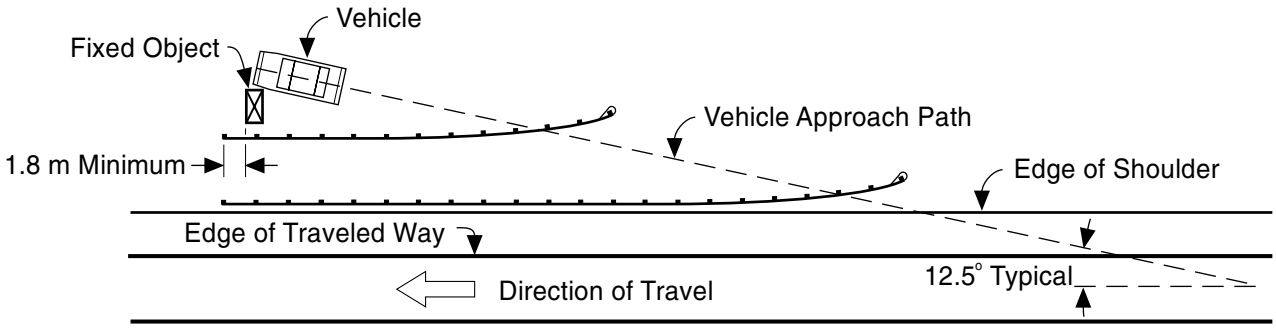
To prevent a vehicle from vaulting over guardrail when it is used in conjunction with a curb or dike, the guardrail face should be on a vertical line with the curb face or on line no more than 50 mm behind the front toe of the dike. The sole exception to this is where the end of the guardrail at a bridge approach is blocked out to overhang the bridge curb face. This is done to minimize the possibility of a vehicle's wheel hitting the end of the bridge curb or sidewalk. Where guardrail is placed on a raised area such as an island, offset behind a curb or dike, the top of the rail must be 685 mm above the top of the curb or dike.

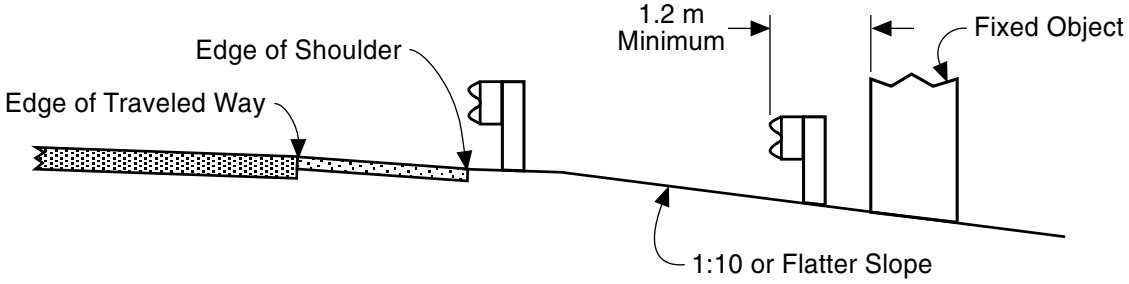
As a general rule, a curb or dike greater than 50 mm in height, ditches, drainage structures, and slopes steeper than 1:10 should not be placed in front of guardrail. If a dike is required in front of the guardrail, Type C dike may be used.

Possible vehicle trajectory must be checked where guardrail placement is proposed on an embankment slope steeper than 1:10. A discussion of trajectory may be found in California Department of Transportation Traffic Bulletin No. 15, Method for Checking the Integrity of Cable and Beam Barriers.

Where guardrail is proposed in an area that is or may soon be landscaped, the growth patterns of the planting should be considered. Earth

Figure 7-3
POSITION OF GUARDRAIL AT FIXED OBJECTS





dikes or berms to contain irrigation water should be eliminated or be of minimal height adjacent to guardrail.

6. ***Flares and Tapers.*** Guardrail flares and tapers are designed to place the ends of guardrail installations away from approaching traffic and provide a smooth transition. How they are placed is controlled by such factors as embankment width, distance between roadways, clear roadside width, and the design of the guardrail itself. The flares shown in the Standard Plans are both general and typical. They are most applicable to new construction, however, any installation may require some modification to fit special circumstances.

   The Type 1M Flare is the basic flare for shielding walls, abutments, and bridge railings. The Type 1M Flare may be used to the right or left of traffic.

   The Type 2 Flare has been deleted from the Standard Plans, but it can be used as a construction detail when a designer determines it is the appropriate treatment for a specific installation. It is intended for use at approaches to structures in wide medians. It is used to shield the median approach to the space between two structures. The Type 2 Flare has a blocked out "W" rail on the backside and can be used where there is a chance of an errant vehicle striking the back of the installation. The approach end with the rail on the back does not lend itself to present breakaway treatments. This flare uses the cable anchor (non-breakaway) at the nose. To provide a crashworthy end, a crash cushion should be placed in front of the nose when the end of the guardrail is within 9 m of the edge of traveled way of approaching traffic.

   The Type 3 Flare is designed to close the median gap between parallel structures. It is designed for a maximum separation of 7.6 m between the edge of shoulders. This is to minimize the angle that the guardrail makes with the road. This flare uses a cable anchor (non-breakaway) at the nose. To provide a crashworthy end, a crash cushion shall be placed in front of the nose.

   The Type 4 Flare is designed for use between parallel structures where there is 3.8 m or less between the edges of shoulders. Another use occurs where collector, frontage, or other service roads are close to each other. In any situation the nose of the adjoining rails must be set as far from approaching traffic as possible. This flare also uses a cable anchor (non-breakaway) at the nose. To provide a crashworthy end, a crash cushion shall be placed in front of the nose when the end of the guardrail is within 9 m of the edge of the traveled way of approaching traffic.

   The Type 5 Flare is intended to shield a fixed object in a median or separation between opposing traffic. The object may be a structure support, an overhead sign support, or some other object. The approach end of the envelope is set away from approaching traffic. The face of the guardrail should be set out 1.2 m from the object. If it is not possible to get 1.2 m clearance, then the reduced post spacing of a transition should be used past the object. This flare uses a cable anchor (non-breakaway) at the nose. A crash cushion shall be placed in front of the nose when the end of the guardrail is within 9 m of the edge of the traveled way of approaching traffic. A crash cushion on each side of the fixed object should be considered in place of the guardrail.

The Type 6 Flare is an open-end envelope for use at structure supports, overhead sign supports, or other objects located in separations between traffic proceeding in the same direction. This flare uses a cable anchor (non-breakaway) at the nose. A crash cushion should be placed in front of the nose when the end of the guardrail is within 9 m of the edge of the traveled way of approaching traffic.

The Type 7 Flare for new installations has been discontinued. Existing installations may remain until replacement is necessary.

The Type 8M Flare is intended for shielding roadside objects such as bridge columns and overhead sign supports. This flare also facilitates the extension of guardrail along a series of objects such as structure supports. The guardrail posts may be set against the face of concrete columns, but the rail is not to be fastened to a column. If the rail encroaches into the shoulder, a rail may be fastened to a retaining wall or closed-end abutment, provided a positive anchorage is used at the downstream end of the rail. This flare is appropriate for the approach end of embankment guardrail.

The Type 9 Flare is intended for use at the approach end of guardrail installations employing a buried-end anchor. Care should be taken to maintain a 685 mm height of rail and eliminate all fixed objects over 50 mm in height in front of the rail. Drainage ditches in front of the rail should also be avoided. The slope approaching the rail should not exceed 1:10.

7. ***Details.*** Metal beam guardrail is made up of a 4.8 mm, "W" shaped metal beam nominally 310 mm wide by 80 mm deep mounted on wood or galvanized steel posts and blocks. Additional details are shown in the Standard Plans.

   The rail is blocked out from the post with a block generally of the same material and cross section as the post. Wood line posts are normally 150 mm x 200 mm x 1.83 m with the 200 mm dimension installed perpendicular to the rail element. All wood posts and blocks for guardrail must be pressure treated to resist decay. The approved steel post is a galvanized MW150 x 14 hot-rolled, wide-flange post 2.0 m long. Steel posts must be longer than wood posts in order to develop the same soil bearing resistance. Generally only one type of post, either wood or steel, should be used in a run of guardrail.

   Where embankment width between the edge of shoulder and hinge point is less than 0.9 m, there is not sufficient soil to support a standard length guardrail post. If there is at least 0.6 m but less than the normal 0.9 m of embankment, a 2.1 m long, 200 mm x 200 mm wood post should be used. This design may also be used where embankment material is non-cohesive. If there is less than 0.6 m between the hinge point and the edge of shoulder, a 0.6 m diameter cast-in-drilled-hole pile should be used to support a 150 mm steel post. Details for these alternate designs are shown in Figure 7-4, Guardrail On Narrow Embankments.

When it is necessary to continue a roadside guardrail across a low-fill box culvert, pipe culvert or overside drain, full embedment of the guardrail post(s) may not be possible over the culvert due to the shallow soil cover. Posts located in the overside drain are undesirable and are often set back behind the drain with multiple blocks. The use of more than two blocks can cause guardrail rotational problems and should be avoided. One or two posts located directly over the culvert or drain may be eliminated and the guardrail spanning the gap doubled to provide the necessary stability. Design details are shown in Figure 7-5, Long Span Nested Guardrail. This design should not be used in transition areas.

Where larger posts are required in guardrail transitions approaching fixed objects, the wood posts are 250 mm x 250 mm with 200 mm x 200 mm blocks. The alternate steel posts are a MW150 x 22 section and the blockouts are a 150 mm x 150 mm section with walls 4.8 mm thick. All steel parts are to be galvanized. Backup plates, which are 300 mm lengths of guardrail, must be used between the rail element and all metal blockouts at posts without rail splices. This minimizes the possibility of the rail element tearing on the edge of a blockout during an impact. Details of the guardrail transition are shown in the Standard Plans.

Adjustable rail-height guardrail posts may be used where it is anticipated that an overlay will be placed on the shoulder within the next 10 years. The adjustable post has three predrilled holes that allow the rail element and block to be raised when an overlay is placed on the shoulder. Details are shown in Figure 7-6, Adjustable Height Guardrail.

Guardrail can be installed on curving alignment without special fabrication where the radius of curvature is more than 45 m. Where the radius of curvature will be 45 m or less, down to a minimum radius of 1.5 m the rail elements require shop rolling to the required radius. Installations of guardrail with specially fabricated components should be held to a minimum to reduce the need to stockpile special components for maintenance. Also where special components are not stockpiled, the delay in ordering and receiving replacements unnecessarily extends the exposure for traffic. The rail elements for guardrail are available in two laying lengths, 3.8 m and 7.6 m. The longer elements create problems for later maintenance work because trucks with longer beds are required to haul the rail elements.

Where guardrail is to be installed on an existing highway or in conjunction with existing roadside features, slopes, clearances, dimensions, underground utilities, and material relating to the roadside feature should be verified. This is especially important where connections to existing structures are proposed. Masonry walls and lightly reinforced concrete bridge railing parapets should not be used as anchorage for guardrail. Details for assembling guardrail are shown on the Standard Plans or Special Details of Contract Plans. The layout of guardrail installation should be shown on the Contract Plans.

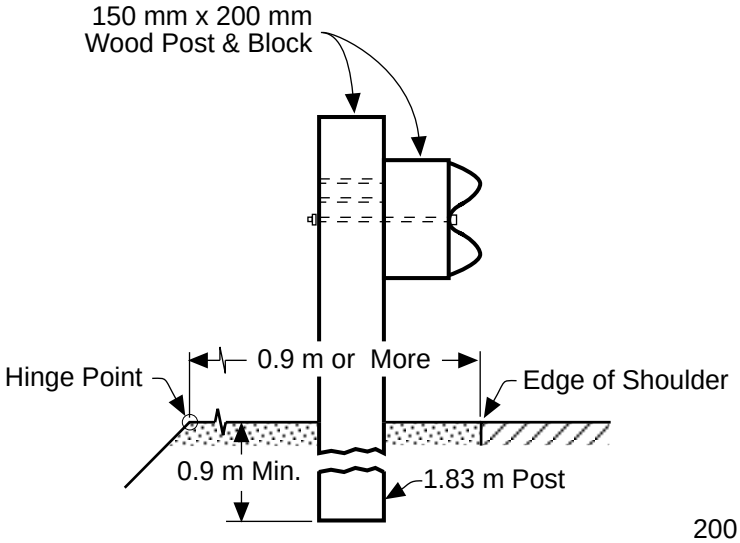
Galvanized steel guardrail provides some supplemental value as a delineation device. Where necessary, this delineation ability can be enhanced with reflective delineation devices as described in Chapter 6 of this manual.

Reflective delineation devices used on guardrail installations should be aimed to provide optimum visibility. Guardrail located more than 3.6 m from the roadbed should not have reflective delineation devices installed. Guardrail intruding on the roadbed, such as at approaches to narrow bridges, warrants additional delineation treatment as described in Chapter 6.

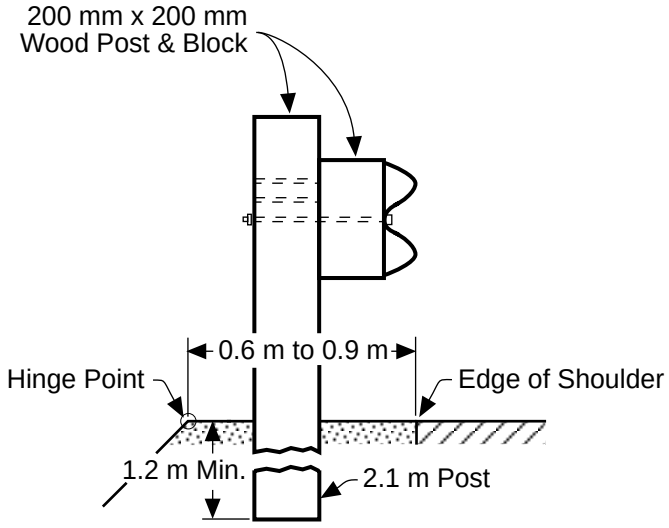
Weathering steel or ungalvanized steel is not to be used for new installations of guardrail or median barrier on state highways.

Single Thrie Beam Barrier should be used as guardrail only in special situations where additional width of rail is required. The rail elements are 50 percent heavier than metal beam guardrail. It uses a nominal 510 mm wide x 80 mm deep, three-ribbed, galvanized metal beam with the top of the beam generally 810 mm above the surface beneath the rail. Other installation details are similar to those for metal beam guardrail.

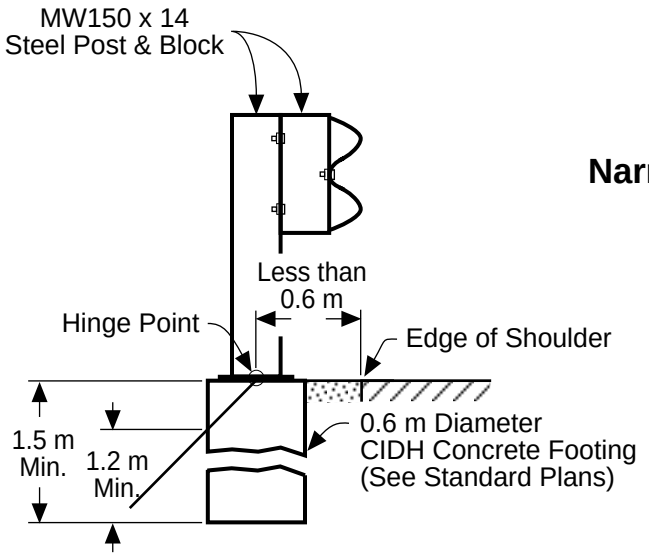
Figure 7-4
GUARDRAIL ON NARROW EMBANKMENTS



Standard Condition

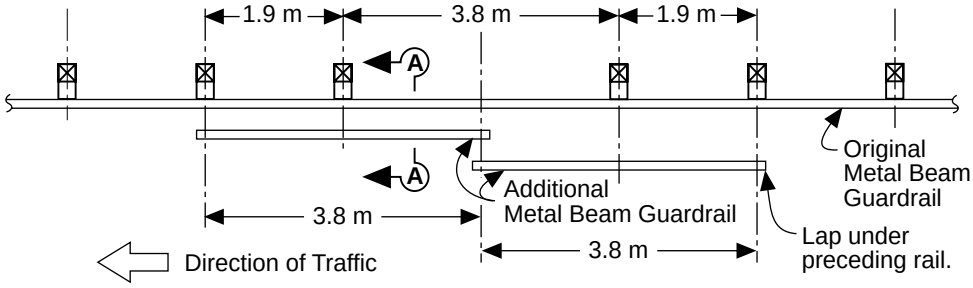


Narrow Embankment or Non-Cohesive Soil

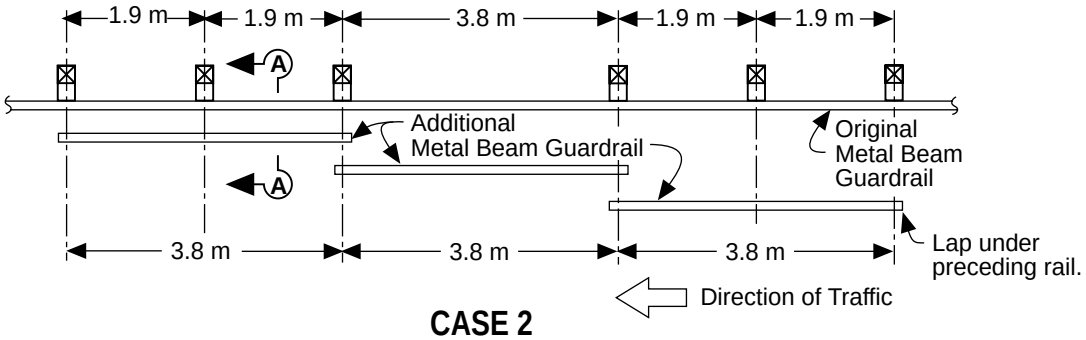


Very Narrow Embankment

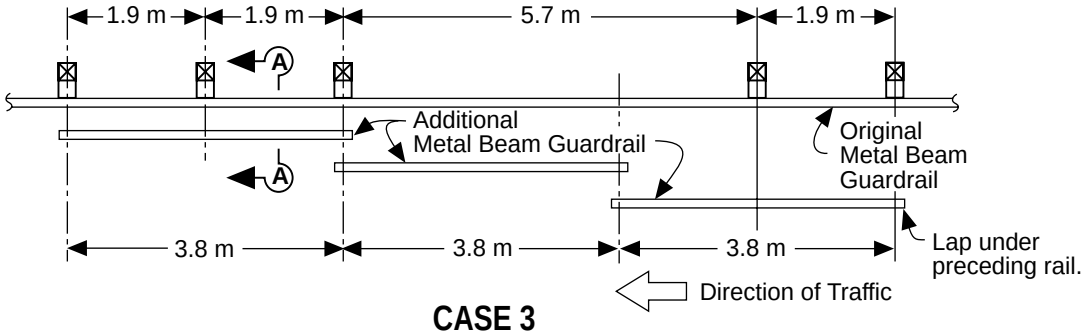
Figure 7-5
LONG SPAN NESTED GUARDRAIL



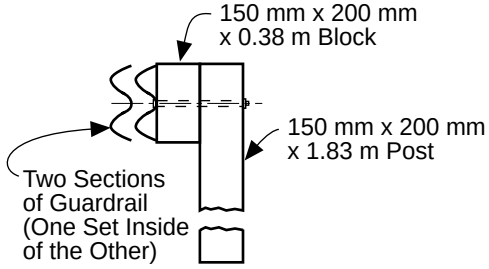
CASE 1
One Post Omitted (Splice in Center)



CASE 2
One Post Omitted (Splice at Posts)



CASE 3
Two Posts Omitted

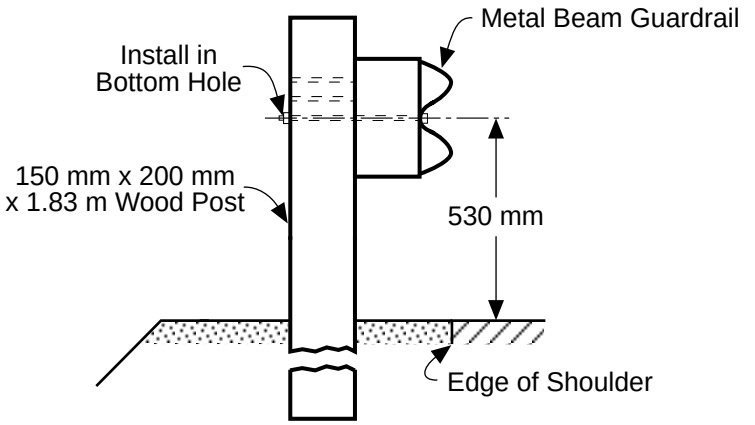


Section A-A

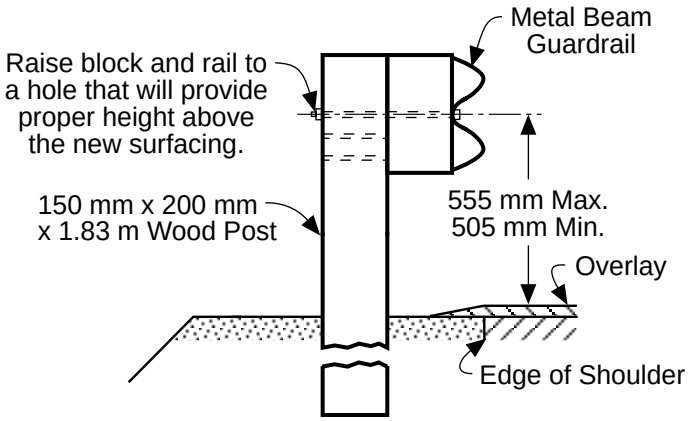
Notes:

1. **Use Case 1 or Case 2 when one post is omitted.**
2. **Use Case 3 when two posts are omitted.**
3. **For other details, see Standard Plans A77A, B, and C.**

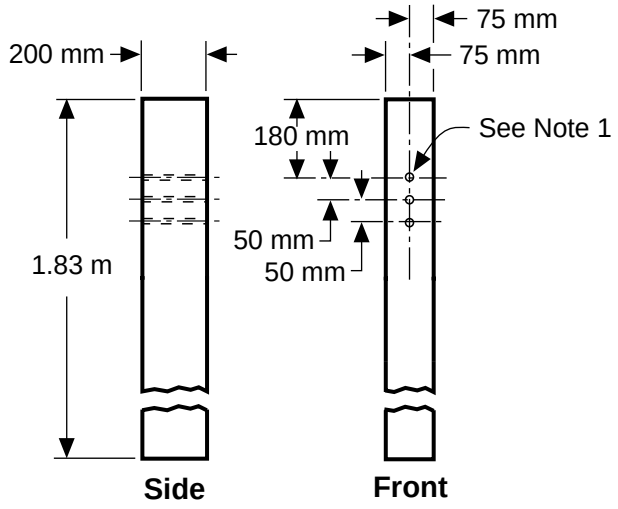
Figure 7-6
ADJUSTABLE HEIGHT GUARDRAIL



Initial Installation



Adjusted Rail Height



Post Detail

NOTES:

1. All holes in wood posts and blocks shall be 20 mm in diameter ± 1.6 mm.
2. For additional details, see Standard Plans.

Median Barrier 7-04

7-04.1 Purpose

Ideally, median barriers should:

1. Reduce the risk of an out-of-control vehicle crossing the median and colliding with opposing traffic.

2. Reduce the risk of deflection back into the traffic stream of a vehicle colliding with the barrier.

3. Decelerate the errant vehicle within tolerable limits.

While median barriers are capable of preventing nearly all of the cross-median accidents, their installation will result in fixed-object accidents that might not otherwise occur.

7-04.2 Barrier Types

The approved standard types of median barriers for new installation are: (1) concrete median barrier, and (2) thrie beam barrier (single or double). Headquarters approval is required for any new installation or reinstallation of metal beam barrier or cable barrier.

7-04.3 Study Warrants

A. ***Freeways.*** The median barrier study warrants shown in Figure 7-7 have been developed through extensive study of freeway cross-median accidents. The need for a barrier should be considered on freeways whenever these study warrants are met and an accident history is developing. Any decision to install or not to install a barrier where study warrants are met should be thoroughly documented.

When the ADT is less than 20,000, the probability of an out-of-control vehicle crossing the median and colliding with an opposing vehicle is low. When the median width is more than 23.0 m the probability of an out-of-control vehicle reaching the opposing lanes is low. Barriers in these cases should be considered only if there is an unusually high number or rate of cross-median accidents involving opposing vehicles. A cross-median accident is strictly defined as one in which an out-of-control vehicle crosses the median of a 4 or more lane road and strikes, or is struck by a vehicle from the opposite direction.

With any ADT or median width, barriers should be considered if there has been a high rate of out-of-control cross-median accidents involving opposing vehicles. A rate, based on at least three accidents in 5 years, of 0.31 cross-median accidents per kilometer per year of any severity or 0.073 fatal cross-median accidents per kilometer per year involving opposing vehicles justifies analysis to determine the advisability of a barrier. Where less than 5 years of accident data exists and the rate criteria is met, further analysis should be conducted to determine the advisability of a barrier.

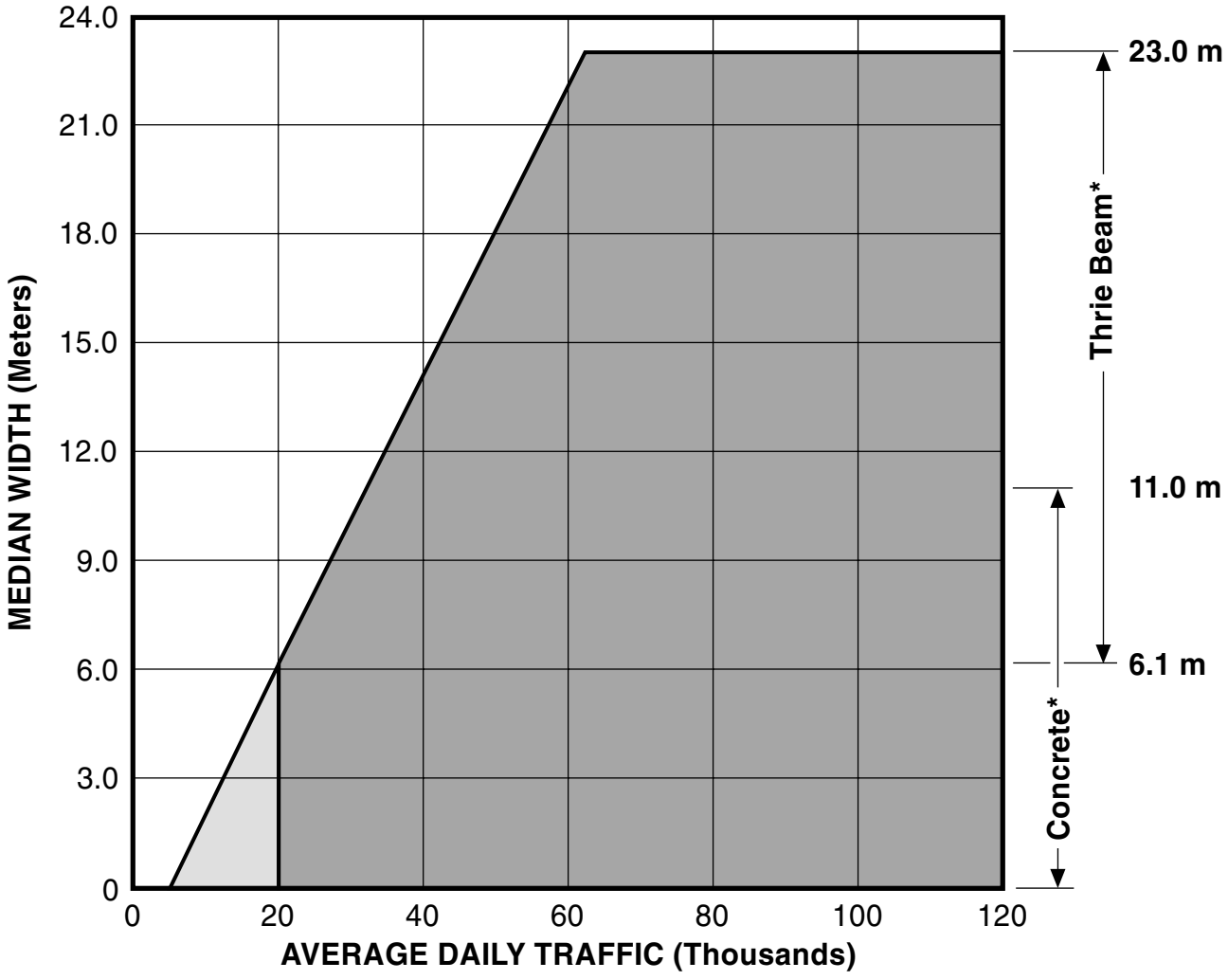
Median barriers should be provided on new construction whenever it is anticipated that they will be justified within five years after construction.

Temporary median barriers should be considered for narrow construction zone detours with large traffic volumes.

Temporary Railing (Type K) is the appropriate barrier for most situations, however other temporary barriers are available and should be considered where appropriate. Temporary Railing may also be used for falsework protection and as a roadside barrier to protect construction sites.

B. ***Non-freeways.*** Median barriers can be an appropriate solution to cross-median accidents on multi-lane (two or more lanes in each direction) expressways and multi-lane conventional highways. The volume/median width and accident study warrants apply to freeways only, but they may be used as a guide for non-freeways.

Figure 7-7
FREEWAY MEDIAN BARRIER STUDY WARRANTS



***For additional guidance on barrier type, see Section 7-04.4.**

When installing median barrier on non-freeways a problem is created at each intersection opening in the barrier. The two ends of the barrier in this situation require special treatment. Careful consideration of the number of intersections, accident history, alignment, driveways, grade, and sight distance as well as traffic volumes and median width must be given for non-freeway installations. It is the engineer's responsibility to determine, decide, and document the best improvements.

7-04.4 Criteria for Choice of Type

Each barrier system exhibits characteristics that make a given type of barrier more desirable in one location than another type of barrier. These characteristics are:

1. ***Concrete Barrier.*** This rigid barrier does not deflect upon impact, but dissipates impact energy within the vehicle suspension system at shallow angle impacts and by displacement of vehicle sheet metal at severe impact angles. The severity of impact can be greater with concrete than with thrie beam barriers at high angles. Impact angles tend to be higher with wider medians. This barrier requires little maintenance; consequently, traffic is not disrupted by extensive maintenance operations, and maintenance workers are not exposed to the hazard of large volumes of relatively high-speed traffic. Concrete barrier is believed to have the highest percentage of unreported "accidents" since, in flat angle collisions with this barrier, most vehicles are redirected with minimal damage and are able to drive away. Finally, this is the cleanest barrier, with no projections to collect debris.

2. ***Thrie Beam Barrier.*** This barrier may deflect up to 0.6 m on impact and provide some dissipation of energy through the displacement of posts and flattening of rail elements. Maintenance costs are higher than concrete barrier. Thrie beam barrier can sustain minor impacts without requiring immediate and extensive restoration work. This barrier system occupies more median than concrete barrier. This barrier may be the appropriate type to use where median plants are to be retained.

The installation of median barriers shall be governed by the following general guidance:

1. For medians up to and including 11.0 m wide, concrete barrier shall be used except for medians between 6.1 m and 11.0 m wide where there are special considerations which cannot be corrected by other means, such as flooding potential. Thrie beam barrier may be used in lieu of concrete barrier in these special situation. Such installations must be approved by the Headquarters Traffic Operations Program using the "fact sheet" process after consultation with both District Maintenance and the Headquarters Maintenance Program.

2. Thrie beam barrier may be used in medians less than 6.1 m wide where it is necessary to pass flood water across the highway pavement. Such installations must be approved by the Headquarters Traffic Operations Program using the "fact sheet" process after consultation with both District Maintenance and the Headquarters Maintenance Program.

3. For medians over 11.0 m wide, concrete barrier can be used if it is offset from the center of the median. It is recommended that the barrier be offset 4.3 m from one edge of the traveled way for 14.0 m medians. This will allow adequate space for maintenance activities on the narrow median side and acceptable recovery area for errant vehicles on the wide median side. Where median widths transition from 11.0 m to 14.0 m, the barrier should transition from a centered position to an offset position respectively. For other median widths or special terrain conditions, consult with your Headquarters Traffic Reviewer. If barrier must be centered in the median, thrie beam barrier should be used.

4. For medians up to and including 11.0 m wide where plantings cannot be removed, concrete barrier should be considered. Approval to use concrete barrier can be granted by the Headquarters Traffic Operations Program after consultation with the Headquarters Maintenance Program, and the District maintenance, environmental and landscape architecture staffs. For medians over 11.0 m wide, two single runs of thrie beam barrier should be used.

7-04.5 Barrier Design Details

Construction details for concrete and thrie beam barriers are shown in the Standard Plans. Concrete barrier Type 50 series has "Jersey-style" sides and has been the standard concrete barrier for many years. Concrete barrier Type 60 series has a single-sloped design on the sides. The width of the base is generally 610 mm. The standard height of Type 60 barrier is 915 mm. If glare screen is to be installed, the 1420 mm tall Type 60G concrete barrier should be used. The Type 60S concrete barrier is 810 mm tall and may be used where stopping sight distance would be impaired if the standard Type 60 barrier were used. The basic concrete barrier is normally constructed by slipforming without a footing on pavement. Ends of the barrier at gaps or contraction joints where the concrete and reinforcement is not continuous require a 250 mm deep by 3.0 m long footing under the end of the barrier. This is intended to prevent displacement of the barrier in an impact at the discontinuity. Other versions of concrete barrier usually require fixed forms for construction.

Thrie beam barrier is made up of a 12 gauge triple corrugated galvanized steel beam nominally 510 mm wide by 81 mm deep mounted on wood or galvanized steel posts and blocks. The top of the rail element is 820 mm above the surface at the face of the barrier. The rail is blocked out from the post with a block generally of the same material and cross section as the post. Wood line posts are 150 mm x 200 mm x 1.83 m with the 200 mm dimension perpendicular to the rail element. All wood posts and blockouts must be treated to resist decay. The steel line post is a galvanized MW150 x 14 hot rolled wide flange post 2.0 m long. The ends of thrie beam barrier must be anchored to ensure expected performance.

Where larger posts are required in transitions approaching fixed objects or transitions to concrete barrier railings, the wood posts are 250 mm x 250 mm with 200 mm x 200 mm blockouts, steel posts MW150 x 22 section and the blockouts are a 150 mm x 150 mm tubular steel section with walls 4.69 mm thick. Backup plates must be used between the rail element and all metal blockouts at posts without rail splices. This minimizes the possibility of the rail element tearing on the edge of the blockout during an impact.

Where a double-faced thrie beam barrier is proposed and a saw-toothed median section

requires the rail elements to be mounted at different elevations, steel posts should be used. Thrie beam requires two mounting bolts that pass through the blockouts and post. For normal installations, the two parallel holes are drilled in a jig at the manufacturing plant. Field drilling a second pair of holes parallel to each other and the original pair is quite difficult and should not be done. Furthermore, the added holes in the line of the grain create a weakened plane in the post that can affect the barrier's performance.

Pavement rehabilitation projects employing thick layers of new paving can compromise the performance of existing median barriers. Normally, Type 50 concrete barrier can tolerate the addition of 75 mm of added pavement against its base without remedial measures being required. This reduces the effective height of this barrier to 735 mm. Where thicker pavement overlays are planned, a special detail is available for a 200 mm cap to be cast on top of the existing barrier.

Thrie beam barrier can tolerate a height deficiency of 50 mm. Where pavement overlays will result in more than a 50 mm height deficiency, corrective measures are necessary. Where the thrie beam barrier is supported on wood posts and the ground around the post is paved, the rail installation may be jacked up and a 50 mm x 150 mm x 300 mm treated Douglas Fir block nailed to the post at the pavement surface. The post may be jacked up no more than 125 mm without adding surfacing around the post. In unpaved areas, it is necessary to remove and reconstruct thrie beam on wood posts to ensure that it will remain at its functional height. Where thrie beam barrier is mounted on steel posts, height deficiencies of up to 150 mm may be corrected by using taller steel blockouts.

Isolated freestanding ends of median barriers are substantial fixed objects. Hence, they must be protected from impacts by approaching traffic. This may be done by flaring the end of the barrier away from approaching traffic or placing an appropriate crash cushion at the approach end of the barrier. Sloping ends or ends that are turned down into the ground are not acceptable.

The total cost of barrier installation can vary considerably from project to project depending on the amount and type of site preparation required.

7-04.6 Median Design Considerations

Many of the difficulties encountered with irregular medians or continuous obstruction in the median can be avoided by the following considerations:

1. ***Longitudinal Median Dikes.*** When required, the dike should be as close to the thrie beam barrier as possible. When placed in front of thrie beam barrier, dikes should be 100 mm high or less. The dike should not be placed between 0.3 and 4.0 m in front of the barrier. Dikes over 100 mm high shall not be placed directly under the barrier. Dikes shall not be placed in front of concrete barriers.

2. ***Median Ditches.*** Drainage ditches should be as shallow and as flat as possible. Where deep ditches are unavoidable, a barrier may be needed on both sides of the ditch.

3. ***Median Drainage.*** Thrie beam barrier is adaptable to most median drainage conditions. Concrete median barrier, however, may require special designs to provide drainage. Slotted drain inlets are the recommended means of providing drainage in paved medians with concrete median barrier. Design details for these are contained in the Standard Plans. Where a concrete barrier must span or cross an existing drainage inlet, special barrier gap

closure details are available. Passing runoff under a concrete median barrier with scuppers on an all-paved cross section is not desirable. What was sheet flow becomes concentrated into streams across the lower roadway. Scuppers, if used, should not extend higher than 75 mm at the base of the barrier. Also, each scupper should be no more than 0.9 m long and a series of scuppers should not occupy more than 25 percent of any 6.1 m length of concrete barrier. Where a highway requiring median barrier is located in a flood plain and it is necessary to allow floodwaters to pass over the highway, thrie beam barrier should be used. For an additional discussion of median drainage, see Section 834.2, Median Drainage, of the Highway Design Manual.

4. ***Raised Medians.*** Barrier height should be measured from the median surface. Median barriers should not be placed on raised medians.

5. ***Flat Medians.*** On paved flat medians, the barrier height should be measured from the paved surface exclusive of any localized ditch surface. Medians adjacent to concrete barriers should be paved.

6. ***Planted Medians.*** Where plants are located in the center of the median, and the plantings cannot be removed, two single barriers, one on each side of the plants, should be placed. See Section 7-04.4, Criteria for Choice of Type, to determine if the use of concrete of thrie beam barrier is appropriate. Earth berms used with median plantings should be eliminated.

7. ***Maintenance.*** Care must be taken that median maintenance or construction work done after a median barrier is in place does not change the effective height of the barrier.

8. ***Future Construction.*** Where traffic lanes are to be added to the median within five years of barrier construction, the median grade line should be adjusted and the barrier installed for the ultimate condition. If it is not practical to do this, concrete barrier should not be used since, unlike the other barrier types, the height of concrete cannot be readily adjusted.

9. ***Median Cross-Slope.*** Where median cross-slopes are greater than 1:10, vehicle trajectory can affect barrier performance. Using the procedures outlined in Traffic Bulletin No. 15, the relationship between median and traveled way cross-slopes should be checked to ensure desired barrier performance.

10. ***Adding Lanes in the Median.*** Where lanes are added in the median reducing the width of the median, the median barrier type to be used should be selected in accordance with Section 7-04.4, Criteria for Choice of Type. In some cases it will be necessary to remove existing non-concrete barrier and replace it with concrete barrier. Costs associated with the change in barrier type should be included in the preliminary scoping document estimate.

7-04.7 Emergency Passageways

Except for emergency passageways in median barriers, median openings are not allowed on freeways. The use of passageways shall be kept to a minimum and carefully located to provide good stopping sight distance to and from the opening along the freeway. Emergency passageways may be appropriate for highway patrol vehicles, emergency service vehicles such as tow trucks, ambulances, fire fighting apparatus and maintenance equipment. The need for such openings and their locations shall be established by the District in cooperation with the local Department of Highway Patrol office, fire district and emergency services. Emergency openings in glare screens for limited passage of stretchers or personnel are covered in Section 7-04.8.

Where emergency openings are provided, they shall be designed based on the following considerations:

1. ***Types of Vehicles.*** Passageways are designed for motorcycles or for motor vehicles. Motorcycle openings are 1.8 m to 2.4 m long, and openings for motor vehicles are 3.7 m to 4.9 m long.

2. ***Types of Passageways.*** Permanent openings and temporary openings with removable sections of barrier are the two types of passageways used. Permanent openings for motorcycle passage only may be provided in concrete and thrie beam barriers. Passageways for motor vehicles shall be by use of temporary, removable sections of barrier or permanent openings where the barrier ends are offset away from approaching traffic. All temporary openings shall be closed immediately after use.

3. ***Spacing of Passageways.*** By a combination of interchange ramps and passageways, provisions for access to the opposite side of the freeway may be provided. Access shall not be more frequent than at 4.8 km intervals.

4. ***Median Widths.*** The median must be wide enough to accommodate turning vehicles safely, and contain the barrier with any necessary flares. Therefore, motorcycle passageways should not be provided where the median is less than 6.7 m wide. Motor vehicle passageways should not be provided where the median is 9.8 m or less in width, unless there are unusual circumstances.

5. ***Barrier Design Details.*** Designs for barrier passageways are shown on the standard plans.

7-04.8 Glare Screens

1. ***General.*** Glare screens are designed to screen out the headlight glare of opposing traffic. Glare screen may be considered on new or existing median barriers where the median is 6.1 m or less in width except on horizontal curves where glare screen would reduce sight distance to less than the stopping distance for the design speed. Glare screen should not be installed in medians wider than 6.1 m.

   Glare screen should be installed where engineering evaluations show that the glare screen would be of overall benefit to the motorist considering the cost and other impacts of the glare screen. An engineering evaluation is required for all projects involving construction within the median

for medians 6.1 m wide or less. Engineering evaluations should consider glare due to the combined effects of grades, horizontal alignment, and traffic volumes. Public complaints are considered in the evaluation. On route segments with scenic views, the sensitivity of the public to the blocking of these views should be considered. The engineering evaluation shall be incorporated in the appropriate project development report as specified in the Project Development Procedures Manual.

Based on engineering evaluations, glare screens may be installed on segments or spot locations along frontage roads or at entrance and exit ramps. Chain link fence with slats may be appropriate in these situations.

2. ***Thrie Beam Barrier.*** Glare screen is not generally used with thrie beam barrier.

3. ***Concrete Barrier.*** When glare screen is determined appropriate, the standard permanent glare screen for this barrier is concrete glare screen.

4. ***Plantings.*** Where plantings exist in the median, glare screen may be considered on structures with decked medians. When plantings are not in place but are planned, decked medians may include provisions to accommodate glare screen in the future.

5. ***Emergency Openings.*** When glare screen is included with the barrier, openings may be provided at approximately 180 m intervals if requested by the California Highway Patrol. In areas with above average traffic collision rates, openings may be spaced at 90 m intervals. Spacing may be varied to provide such an opening at each structure crossing over the highway.

7-04.9 Delineation

Commercial retroreflector units are available where it is necessary to provide enhanced delineation along median barriers. Reflective delineation along thrie beam barriers is provided by installing approved retroreflective units on top of the posts. Reflective delineation for concrete barriers is obtained by securing approved retroreflective units to the top of the barrier.

Crash Cushions 7-05

7-05.1 Purpose

Crash cushions, also known as impact energy attenuators, are intended to protect a motorist from the consequences of a collision with a fixed object that cannot be removed or where other protective systems are not suitable. A prime example occurs at gores on elevated structures. Here the intersecting structure railings, often with a vertical pier or sign support, create a fixed object.

7-05.2 Available Crash Cushion Types

Types currently available include arrays of sand-filled plastic drums and several mechanical systems relying on water displacement, a crushable medium and metal deformation to dissipate impact energy. Information about designs and types of crash cushions currently approved for use on State highways is available from the Traffic Operations Program in Sacramento.

7-05.3 Placement

Crash cushions should be installed at fixed objects that cannot be economically removed or made breakaway. They should also be installed to shield fixed objects where guardrail is inappropriate.